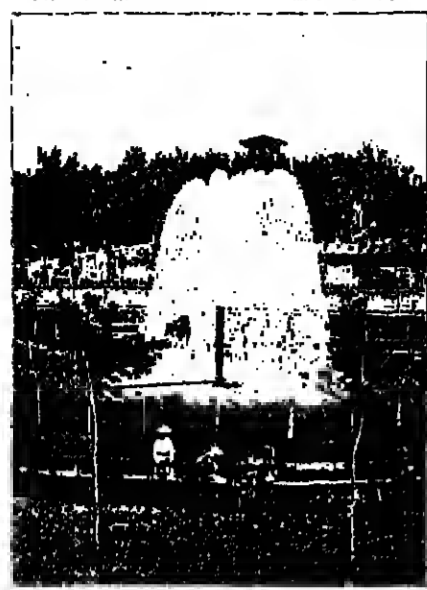




# WaterWatch



WaterWatch  
News of the hydrology section

Editor: Mary E. Anderson, Department of  
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## News & Announcements

### Coaxing Clouds Over Jerusalem

It is raining 15% more in certain parts of Israel these winter days, and the man responsible for it is Avraham Gagin of the Meteorological Department of Jerusalem's Hebrew University.

Gagin heads the research that has made Israel the world leader in artificially induced precipitation, where the population currently consumes more than 95% of the available water supply.

Using the conventional methods of cloud seeding, the injection of a fine powder of silver iodide into a cloud, Gagin modestly says, the "powers" of his staff lie in knowing which clouds to seed. "We don't make rain," he says, "we simply encourage the rain-producing cloud to let down more precipitation than it naturally would have." Israeli latter the clouds with silver iodide from above and below. Crop dusting planes are used, spraying the cloud at low altitude from generators under the wings. From the ground, silver iodide is sent up through vast batteries of generators located throughout the country.

Although in 1982-1983 Israel experienced one of the wettest winters in recorded history of this area, Israel's water reserves are not only low, but have reached what some experts call a "crisis level." Israel's two main water sources are the sea of Galilee in the north, fed by the Jordan River, and natural underground reservoirs from which water is

pumped to the surface through artesian wells. In spite of the heavy rainfall, the Sea of Galilee is still at its lowest level in 20 years and aquifers are in danger of drying out, consequently suffering damages that can interfere with its smooth water flow. Some critics object to the rainmaking project saying it tampers with nature. Gagin, who sees their point of view, says that "in going back to natural rainfall, we would have to go back thousands of years," before such phenomena as deforestation from overgrazing and the felling of trees influenced the annual rainfall.

The induced rainfall seems to be reversing the depressing situation of water supplies in Israel and, for that matter, in countries that border Israel. When rain-making activities were started, the attempts were a well-kept secret, for no one knew how the cloud seeding would affect the weather of the neighboring Arab states. But when the University of Chicago published data from studies in Arab countries next to Israel, a 30% increase in rainfall was showing up in Jordan, Lebanon, and Syria. Authorities here assume that the Arabs were "not displeased." Israel's rain-making techniques are benefiting countries outside of the Middle East. Recently, a delegation of leading meteorologists and water conservationists from South Africa came in Jerusalem to learn from the experts here. In addition, Israeli meteorologists have been dispatched in Peru where an Israeli company, Agridea, has been employed to develop a vast arid area of that Latin American country.

This item was submitted by Ellen Davidson, Officer of the Consulate General of Israel, New York.

## On The Waterfront

The following members of the Hydrology Section have been selected to receive Presidential Young Investigator Awards (Eos, March 13, 1984, p. 97).

Roman Krzyzostowski, Univ. of Virginia;  
Daniel R. Lynch, Dartmouth College; and Jerry R. Stedinger, Cornell Univ.

Oric L. Louche has been appointed the new director of the Holcomb Research Institute, Indianapolis. He has established three areas of research for the Institute: water sciences, bionic resource analysis, and environmental economics and policy analysis. The water sciences program initially is being developed around the existing Ground Water Modeling Center currently based at the Holcomb Research Institute.

## Opinion

### Mesoscale Meteorology/Hydrology Experiment?

Scientific progress in the field of surface water hydrology appears currently to be constrained by a lack of comprehensive field data involving the coordinated simultaneous observation of many meteorological and hydrological variables at mesoscale. Mesoscale meteorological experiments are under active discussion by (1) a U.S. interagency team and (2) the World Climate Research Program. The hydrologic research community should ensure that its interests are represented in the planning for these unique experiments.

Historically, the field of surface water hydrology has grown out of an engineering need to provide adequate water supplies over the long-term and to provide flood protection in the short term. Early work involved the collection and analysis of station records of precipitation and streamflow, and their use in developing lumped (i.e., one-dimensional) models of the precipitation-runoff behavior of watersheds.

As the field has matured, and as the observational and analytical tools have developed, we wish and need to ask more sophisticated questions:

1. Our growing interest in the behavior of larger physical systems and in climatic regions having predominantly convective storm demands that we deal explicitly with the spatially distributed character of both the atmospheric forcing and the land surface.
2. Our concern with the large-scale environmental impacts of proposed tropical nuclear engineering projects such as deforestation in the Amazon Basin and drainage of the White Nile swamps requires that we consider the interactive behavior of the land surface/atmosphere system.
3. Improvement in short-term hydrologic forecasting, be it for flood warning or for other operational purposes, such as the control of irrigation releases, must involve inclusion of some of the physical/dynamical aspects of precipitation formation.

Advances in these areas requires both deve-

loping and comprehensive data sets, and the latter do not exist. It is the opinion of many hydrologists that our science is currently constrained by the absence of such data. Our Precipitation Committee has undertaken a multi-disciplinary effort to define and stimulate the analytical and experimental precipitation research needed by hydrologists. This Committee is chaired by Vijay K. Gupta of the University of Mississippi, and its membership contains physicists, atmospheric scientists, mathematicians, and statisticians in addition to hydrologists. They have organized a session at the Spring 1984 AGU meeting on Investigations on Mesoscale Precipitation Fields, which is jointly sponsored by the Hydrology and Atmospheric Sciences Sections, and have prepared an article on precipitation research which should appear shortly in Eos.

We hope that this statement of our interests and needs will help bring about a similar interdisciplinary effort on the experimental side.

## Hydrologist Certification: Two Views

I recently received a letter regarding the registration of hydrologists but paid little attention. Now with Peter S. Eagleson's, president of the Hydrology Section, comments in Eos (Jan. 10, 1984, pp. 9-10) I realize there must be quite a controversy. I would like to comment, particularly with regard to the argument that registration will protect the public.

I am a registered professional forester in California. Therefore I am qualified to practice there. Correct? Legally, yes. Professionally, in most regards, no. I have never done the type of forestry work for which the registration law was primarily designed. My experience has been primarily with brushfields and rangelands or with tree species of the subtropics.

With 25 years in forest hydrology research and water resource planning, I could almost surely qualify for registration as a professional hydrologist. My studies include undergraduate and graduate courses in hydrology at the University of California, Berkeley, and Colorado State University. I consider myself a forest hydrologist, but to qualify that to professional hydrologist would be to claim a general level of competence I likely do not have.

Finally, initials are no real protection to the public. I have just finished reading a report by a consulting engineering firm. The report is authored by five PEs and two CPAGs. The report is mostly about trees. It is also mostly incorrect. It is riddled with errors and full of unsupported, inconsistent, and unacknowledged statements. The authors were unprofessional in this case since they did not make sure that someone among them understood how trees grow. As a result the layer of that report will sit in the trash can of all the initials behind the authors' names. I am afraid that unprofessional "professionals" will always be with us in spite of everything.

Hydrology is interdisciplinary by definition. I cannot imagine a hydrologist worthy of the name who does not have a core professional such as meteorology, engineering, agriculture, or even forestry. Requiring a named profession as a prefix, as in forest hydrologist, would be far more meaningful to the public than the term "professionals."

Let's leave it at that rather than trying to decide who is, and who is not "professional."

Robert A. Merriam  
Kailua, Hawaii

I applaud the decision of the Hydrology Section Executive Committee in remaining neutral in the debate concerning government certification of hydrology professionals. The two reasons cited in Water Watch in Eos (January 10, 1984, pp. 9-10) are indeed the ones explicitly put forth by those in favor of state certification. There is, however, a third reason that is seldom stated but nevertheless very much a factor in the minds of many of those behind the certification movement: the regulation of competition, particularly the entrance of new practitioners into the marketplace. By controlling the numbers of practitioners through licensing requirements, state accredited professionals—particularly those who are "grandfathered" in when the law is passed—can limit competition and command a larger share of the available market for professional services.

We are now seeing a trend toward reduced government regulation of many industries, and it will be unfortunate if hydrologists overlook the reasons for and benefits of this trend and instead pursue greater regulation of their own profession. Certification of professional excellence can be readily accomplished within the framework of professional societies such

as the American Society of Civil Engineers without resorting to legal mechanisms to control who can and cannot practice.

Lois B. Holzhauer,  
President  
Applied Geomechanics, Inc.

## Meetings

### Hydrology Days

The AGU From Branch is sponsoring three Hydrology Days to be held April 24-26, in the Student Center at Colorado State University in Fort Collins, Colo. Student papers will be presented on the first day, and professional papers will be presented on the second and third days. John Breckinridge, U.S. Geological Survey, will be the featured speaker at a luncheon on the first day of the program. The title of his talk will be "Water Management: Who are the Managers?" For more information contact H. J. Miel-Seymour, Colorado State University, Civil Engineering Department, Fort Collins, CO 80523 (telephone: 303-491-8519).

### Penrose Conference

A Geological Society of America Penrose Conference on Transport Processes in Fractured Rock, will be held from September 24 to 28, 1984, in Park City, Utah. The objective of the conference is to bring together recent advances in our understanding of the physics of mass and heat transfer in fractured porous media, in simulation methodologies for mass and heat transfer, and in the experimental determination of system parameters. The conference leaders are Leslie Smith and Frank Schwarz. Participation is restricted to about 80 people. For more information contact Leslie Smith, Department of Geological Sciences, University of British Columbia, 6339 St. Johns Road, Vancouver, BC, Canada V6T 1Z4.

### Gordon Research Conference

A Gordon Research Conference on Modeling of Flow in Penetrable Media will be held in Amherst, N.H., July 30 to August 3, 1984. The purpose of the meeting is to discuss recent issues in the modeling of fluid flow phenomena in permeable media. Invited speakers include J. Bear, J. R. Philip, P. A. Witherspoon, R. W. Gillham, H. C. Helgeson, T. A. Hewitt, H. C. Hailu, K. O'Neill, F. M. Richter, J. Noorjand, J. Wheeler, T. P. Mather, L. Dull, R. Ewing, P. Sammis, J. Bell, J. Wallis, A. Weis, L. W. Gellner, W. A. Jury, and S. P. Neuman. The chairman of the meeting is T. N. Narasimhan, Earth Sciences Division, Lawrence Berkeley Laboratory, Berkeley, Calif. Participation is limited to about 100 participants. Applications may be obtained from A. Chukshank, Gordon Research Conference, Pasteur Chemical Laboratory, University of Rhode Island, Kingston, RI 02881.

### Sink Hole Conference

The first multidisciplinary conference on sink holes will be held October 15-17, 1984, in Orlando, Fla. Geologists, engineers, geographers, and others from related disciplines are invited to attend and present papers. The conference is being sponsored by the Florida Sinkhole Research Institute, University of Central Florida, College of Extended Studies, Orlando, FL 32816-0177.

### Irrigation and Drainage Congress

The 12th International Congress on Irrigation and Drainage will be held in Fort Collins, Colo., from May 28 through June 1984. The American Water Resources Association (AWRA) is one of more than 20 cooperating organizations sponsoring the conference. There will be a special session on the impact of the energy crisis on irrigation and drainage and a symposium on new developments in the protection of irrigation, drainage, and flood control structures on rivers. For more information contact Larry Stephens, Executive Secretary, U.S. Committee on Irrigation and Drainage, and Flood Control, P.O. Box 15328, Denver, CO 80215 (telephone: 800-254-3006).

## National Water Well Conference

The National Water Well Association (NWWA) is sponsoring a conference on the Practical Applications of Ground Water Models to be held in Columbus, Ohio, on August 15-17, 1984. The NWWA is also sponsoring the 7th National Ground Water Quality Symposium, September 26-28, 1984, in Las Vegas, Nev. The theme of the conference is "Developing and Implementing Innovative Means of Dealing with Potential Sources of Ground Water Contamination." Abstracts are due May 25, 1984.

For more information on both conferences contact David M. Nielsen, NWWA, 500 West Wilson Bridge Road, Worthington, OH 43085 (telephone: 614-840-9355).

### ACS Groundwater Sessions

The American Chemical Society (ACS) will hold a series of 8 sessions on groundwater in a 3-day period during a national meeting of the ACS to be held April 28 to May 3, 1985, in Miami, Fla. All papers will be invited. For more information contact Wills Garner, U.S. Environmental Protection Agency, Washington, D.C. (telephone: 703-557-0320).

### AGU Fall Meeting: Statistical and Hydrological Criteria in the Safety of Dams

The AGU Surface Runoff Committee is organizing a special session on dam safety at the Fall 1984 meeting in San Francisco. During the last few years, research has been directed toward the analysis of risks and uncertainties, risk-based design and analysis of statistical, geotechnical, and hydrologic issues in the safety of dams. This session shall focus primarily on risk and hydrological factors associated with the design and safety of dams. Papers are solicited dealing with risk-

based design, quantification of risks, uncertainties and probabilities of failure, stochastic aspects of reservoir operation related to flood control and dam safety, dam break problems, and hazard identification. General papers dealing with the mechanics of flow in dam-break situations may be accepted for presentation. The focus of the session will, however, be on risk and reliability aspects of dam safety. Invited papers deal with the use of random field models, probabilistic risk analysis, determination of the composite risk of failure, risk-based design, reservoir operation and dam safety, and relationships of failure probabilities to earthquakes and flood insurance.

Please mail three copies of your abstract to AGU and one to U. Lall, Department of Civil Engineering, 9012 MEB, University of Utah, Salt Lake City, UT 84112 (801-581-6701), the session organizer.

Deadline for special session: August 15, 1984.

### Remote Sensing and Remote Data

The American Society for Testing and Materials (ASTM) is sponsoring a Symposium on Geotechnical Applications of Remote Sensing and Remote Data Transmission in mid-July 1986 at New Orleans, Louisiana. Organized by ASTM Committee D18 on Soil and Rock, the 1-day symposium will be one part of the 4-day spring meeting of that committee.

The purpose of the symposium will be to develop information that can be used to prepare guidelines for the use of new remote sensing techniques for a variety of projects involving geotechnical engineering and to the use of satellite transmission for on-site instrumentation data. The program will be designed to show advantages and disadvantages of various remote sensing and remote transmission techniques, equipment, and programs related to soil mechanics, rock mechanics, geologic engineering, groundwater hydrology, and other scientific input to geotechnical engineering studies.

Offered and invited papers will be scheduled for oral or poster presentation. All papers will be reviewed and considered for publication in an ASTM Special Technical Publication. Presentations will be selected by a Program Committee on the basis of submitted abstracts. Prospective authors are invited to submit a title and a 200-500 word abstract.

# EOS

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Cover. This is a digitally analyzed X-band synthetic aperture radar (SAR) image of waves in the coastal zone at the northern tip of the Goto Islands, Japan. The Goto Islands lie south of the island of Tsushima and west of the Japanese island of Kyushu. The raw SAR image data were collected by the Japan Self Defense Air Force by using a Goodyear AN/APD-4 system on an F-4 Phantom jet. This scene was collected on November 29, 1981, at a speed of 270 m/s from an altitude of 3847 m. The radar depression angle was about 45°. The raw phase history was optically correlated on the precision optical correlator at the Goodyear Aerospace Arizona Division to create strip imagery on 70 mm film. Selected sections on the film were scanned by a vidicon camera and were digitized and processed in the Remote Sensing and Image Processing Laboratory at Louisiana State University, Baton Rouge, LA. The digitized image resolution is approximately 10 npx/inch in this 512 x 512 pixel scene. Digital exploitation included geometric correction to the ground plane, local spectra creation, and detailed environmental analysis. Diagonal

lineations superimposed upon the wave crests are aligned parallel to the surface wind of 9.8 m/s. Their periodic nature allow the surface wind direction to be accurately extracted from local spectra. These wind rows have been interpreted as resulting from convective roll vortices. Existing empirical relations and auxiliary weather data, in conjunction with wind direction and wave period extracted from the local SAR spectra, were used to estimate significant wave height and aerodynamic roughness parameters at the sea surface. Some of these estimated and extracted parameters are incorporated in this sea-state image, which combines original imagery, regionally processed spectra, and text symbols. This image was analyzed by Gary A. Mastin, Oscar K. Huh, and S. A. Hsu of the Coastal Studies Institute, Baton Rouge, as a part of research sponsored by the Coastal Sciences Program, Office of Naval Research, Arlington, Va. Special thanks are given to Kenji Wakui of the Japan Self Defense Air Force for supplying the raw data. (Figure courtesy of Gary Mastin, Sandia National Laboratories, Albuquerque, N.M.)

to symposium chairman A. Ivan Johnson, Consultant, Woodward-Clyde Consultants, Harlequin Plaza North, 7600 East Orchard Road, Englewood, CO, 80111 telephone: 303-425-3611 or 303-484-2770.

To receive information on the symposium or for detailed instructions for submission of abstracts, contact symposium chairman A. Ivan Johnson or Kathy Greene, ASTM Publications Division, 1916 Race Street, Philadelphia, PA 19103 (telephone: 215-295-5414).

## Hydrology at Spring Meeting

The Hydrology Section will sponsor the following special sessions at the 1984 annual spring meeting in Cincinnati (May 14-17):

Groundwater Transport: Field Methods, Mon. PM; Transport Processes I and II, Tues. AM and PM; Mesoscale Precipitation I and II, Tues. AM and PM; Catchment Geomorphology, Wed. AM; Hillslope Hydrology, Thurs. AM; Sediment Storage, Thurs. PM.

The general session on groundwater will be held Monday and Wednesday mornings. The general hydrology session will be held Wednesday afternoon.

## Workshop on Hydrologic Applications of Space Technology

The International Association of Hydrological Sciences (IAHS) and the World Meteorological Organization (WMO) are planning for an International Workshop on Hydrologic Applications of Space Technology: Input to Hydrologic Models and Geographic Information Systems, to be held in Florida in mid to late 1985. The city and exact date will be announced later.

The workshop program will emphasize offered and invited oral or poster papers related to the input of remote sensing and remote data transmission to hydrologic models and geographic information systems. Field trips to NASA's John F. Kennedy Space Center and other points of scientific interest will be part of the program. An exhibit and demonstration of pertinent equipment, systems, and programs will be available, as will a display of related books and periodicals.

Organizations interested in exhibiting equipment, systems, or publications or in demonstrating equipment or software programs should contact A. Ivan Johnson, President, IAHS International Committee on Remote Sensing and Data Transmission, 7474 Upham Court, Arvada, CO 80003. Persons wishing to offer an oral or poster paper for consideration by the program committee should submit a typed single spaced original and one copy of a 400-600 word abstract, in English, to Mr. Johnson at the above address or to J. Nentze, Director, Hydrology and Water Resources Department, World Meteorological Organization, Case Postale No. 5, CH-1211 Geneva 20, Switzerland.

## Meeting Reports

### AGU Hydrology Section

The Executive Committee of the AGU Hydrology Section met in regular session at 4:00 P.M. on Thursday, December 8, 1983, in Room 378 of the Cathedral Hill Hotel, San Francisco, Calif. Seven board members were present with section president, Peter Eagleson, presiding.

#### Report of Meeting Chairmen

A total of 18 sessions were presented in San Francisco, and all were well attended, as was reported by program chairmen Dennis Lettenmaier. Added to the regular sessions of General Hydrology, General Groundwater Hydrology, and Sediment Transport were the following special sessions: Glacier Ocean Interaction, presided Edward Josberger; Orinoco and the Amazon, presided Edward Andrews; Transport and Geochemical Interactions in Stream Water, presided F. E. Benoit; Instream Flow Requirements for Fish, presided Brian W. Mary; Multivariate Modeling of Hydrologic and Other Geophysical Time Series, presided Jose D. Salas and David R. Dawdy; Optimization Techniques for Managing Groundwater and Stream Aquifer Systems, presided Steve Gorelick; Treatment of Evapotranspiration Soil Moisture Evolved Models, presided Arlen D. Feldman and Hubert J. Morel-Seytoux; Statistical Procedures for Estimating of Flood Risk at Gauged Sites, presided J. R. Stedinger; and Searching for More Physically Based Extreme Value Distributions in Hydrology, presided Juan B. Valdes. The session on Glacier Ocean Interaction received the most publicity, with numerous accounts of some of the presenta-

tions appearing in the newspaper. One of the pleasant surprises of the meetings was the high attendance at the special sessions on Optimization Techniques for Managing Groundwater and Stream Aquifer Systems and Multivariate Modeling of Hydrologic and Other Geophysical Time Series. Both sessions were highly interdisciplinary, attracting numerous scientists from other sections of AGU.

In his absence, a memorandum from John R. Rier, the program chairman for the AGU Spring Meeting in Cincinnati, was given. Seven symposia in special sessions are planned for the Spring Meeting. Two sessions in Water Quality: one session in Stochastic Elements of Nonpoint Source Pollution Models and Water Quality and Geochemistry of Small Catchments; one session in Erosion and Sedimentation on Sedimentation Storage in Rivers and Estuaries; one session in Surface Runoff on Hillslope Hydrology; two sessions in Groundwater, Miscible and Immiscible Transport in Groundwater and Field Methods for Supporting Groundwater Chemical Transport Models; and one session in Precipitation in New Research Directions in Modeling of Precipitation in Space and Time. It looks like a full schedule of topics which should attract excellent speakers and audiences.

#### Reports of the Editors of Water Resources Research

Steve Burges reported that a mild editorial board meeting was held this year. With the dust of the page charge issue having settled, no major rewording controversy was caused. Steve Burges introduced Ronald G. Cummings, the new editor of the social science side of *Water Resources Research*. Cummings stated that his goals were to continue the journal's tradition of publishing high quality, policy sciences papers dealing with water-related topics, and to increase the level of participation and involvement with the journal by scholars in sciences concerned with systems analysis and operations research as well as the social sciences: economics, political science, law, history, and geography. Cummings has sent 1,500 letters to individuals in water research, department chairpersons, and directors of state water resource research institutes calling for quality, water-related papers dealing with policy issues. Cummings has added five new associate editors to his staff and has contacted previous and existing associate editors for continuity and assistance in the examination of *Water Resources Research*.

In a memorandum to Peter Eagleson, Mary Anderson, the editor of *Water Watch*, a new hydrology news column appearing in *Eos*, reports that the first column has appeared in early January. She also requested that anyone with ideas for a logic for the column should send them to her: Mary Anderson, Department of Geology and Geophysics, 1215 W. Dayton Road, University of Wisconsin, Madison, WI 53706. Contributions or future editions of the quarterly column are welcome.

#### Report of the Technical Committees

Eight of 10 technical committees submitted reports on their activities to present and their plans for the future. These reports will be sent to Mary Anderson to be abstracted and the abstracted versions to be published in *Water Watch*. Those committees submitting the written reports were Erosion and Sedimentation, Water Quality, Precipitation, Surface Runoff, Policy Sciences, Soil Water, Snow and Ice, and History and Heritage.

#### Status of Soviet Hydrology

A written report was submitted by Nathan Buras to the Executive Committee on the status of the publication, *Soviet Hydrology*. Buras reports that, although *Soviet Hydrology* publishes (translated) papers from a broad range of sources, these papers seem to be specific technical applications of well-established principles. He points out that this does not diminish the value of these papers in professionals, but it is questionable whether or not they are of much use to researchers.

To be sure, high-quality papers are published in the Soviet scientific literature in the area of hydrology and water resources, but they are scattered in several periodicals. The important Russian publication is *Vater Resoursses*, which, it appears, is currently translated in toto into English. Another important source of original papers is the Doklady of the various sections of the Soviet Academy of Sciences. For example, important papers regarding the design and operation of surface reservoirs may be found in the section on cybernetics. Buras suggests that a screening board be established within the Soviet Union to help in the process of choice. Such a screening board was discussed with our Soviet colleagues in Hamburg, and its implementation is now being considered.

#### AIH

Peter Eagleson, section president, reiterated the Executive Committee's position in regard to the American Institute of Hydrology. AGU is a research body and, as such, should not be actively involved in the process of certifying hydrologists. He referred to a letter by Jay Lehr of the National Water Well Association (cont. on p. 324)

(cont. from p. 323)

tion where state certification activities are being promoted as opposed to national certification. It was a consensus of the Section Executive Committee that all further action or discussion about AHC come to an end.

### Business Meeting

The business meeting of the AGU Hydrology Section met in a luncheon session at 12:00 noon on Wednesday, December 7, 1983, at the Holiday Inn Golden Gate. The meeting was presided over by Section President Peter Eagleson.

### Death of James Amoroso

It was with great sadness that Peter Eagleson announced the untimely death of James Amoroso of complications due to previous open heart surgery. Amoroso, a long-time member of AGU and past recipient of the Horton Award, had been active in the field of hydrology until the time of his death. He served on numerous section committees as an associate editor of *Water Resources Research* (WRR) and, at the time of his death, was chairman of the Horton Scholarship Committee. He will be missed by all.

### New Editor of the Social Science Side of WRR

Ronald G. Cummings, professor of economics at the University of New Mexico, was introduced as the new editor of the social science side of WRR. Cummings promises to be an extremely active editor, continuing and expanding the past work of Jared Colton, former editor.

### Physical Science Editor of WRR

Steve Borges' term as editor of the Physical Science side of WRR expires in July 1984. Rafael L. Bras has been named chairman of the nomination committee to fill the vacancy. Suggestions for nominations should be sent to Rafael L. Bras, Ralph M. Parsons Laboratory, Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139.

### New Journal on Applied Hydrology

Some interest has been voiced among Hydrology Section members for the formation of a new journal on applied hydrology. An informal polling of the membership has been suggested. An opinion, for or against, should be sent by letter to Peter Eagleson, Room 48-335, Massachusetts Institute of Technology, Cambridge, MA 02139.

### Policy Sciences Committee

The old Water Resource Systems committee has been reorganized and renamed. It is now known as the Policy Sciences Committee. The new committee chairperson is Helen Ingram, Department of Political Science, University of Arizona. Helen is a renowned scientist in the field of water policy and institutions.

### Committee on History and Heritage

William Buck has been named chairman of the History and Heritage Committee. This new committee will promote items, articles, and reports on the history of the hydrologic sciences. There are funds available for historical activities through the AGU Council. Correspondence regarding the committee should be addressed to William Buck, U.S. Geological Survey, National Center, MS 431, 12201 Sunrise Valley Drive, Reston, VA 22092.

### Program Chairman

Peter Eagleson gave high praise to Dennis Lestemaier for his excellent organization of this year's fall meeting. Dennis will continue on as Program Chairman for the Fall 1984 Meeting. All should be reminded that the Spring 1984 Meeting is to be in Cincinnati, Ohio, May 14-17.

### Chapman Student Travel Fund

A general AGU fund, the Salines Chapman Memorial Lecture Fund, is available for support for travel for a limited number of students to Chapman Conferences where no other travel funds are available. One student will be supported for a meeting of 60-80 attendees, two students may be funded for a meeting with over 100 attendees. The grants will cover economy airfare only.

### Reserve Fund

The AGU Council has decided to maintain a liquid assets fund of 50% of annual expenses to allow AGU to weather a severe economic storm or to take advantage of unforeseen opportunities. To reach this 50% goal, about 5% of expenses will be budgeted from surplus each year. This amount is approximately \$300,000 a year. The 50% goal translates into a reserve fund of \$1,360,000.

### Horton Award

This year's recipient of the Horton Award was David A. Wooliser. Wooliser is a research scientist for the Agricultural Research Station, Tucson, Arizona, and an adjunct professor of hydrology and water resources.

University of Arizona, Tucson, Arizona. He received the award for his longstanding work in watershed systems.

## Flood Estimation

The three sessions on flood estimation at the Fall AGU meeting were well attended and quite successful. A brief synopsis is provided here. On Wednesday, S. Yankovitch and K. Ashenowicz both illustrated how nonparametric procedures could be employed to estimate probability density functions. Such procedures do not require that one assumes that flood flows come from a pre-specified parametric family. Other papers addressed how information other than just the at-site gauged record could be employed to estimate flood risk. J. Salas discussed the use of record augmentation procedures based on bivariate Gumbel distributions. T. Cohn showed how "historical" records documenting the absence or occurrence of large floods could dramatically improve design flood estimates at gaged sites. Finally, G. Tasker proposed the use of generalized least squares (GLS) procedures for deriving estimators of flood quantiles as a function of basin characteristics; the GLS technique accounts for the sampling error and cross correlation of the flow quantile estimators. The procedure provided more accurate parameter estimates, much better estimates of the accuracy of the model's parameters, and an almost unbiased estimate of the prediction error.

During the formal morning session on Friday, several authors again considered the use of regional information in flood risk estimation. D. Wall discussed a study examining use of both historical flood records and of regional regression equations which also demonstrated the value of historical flood information. J. Herrin presented an evaluation of the Water Resource Council's pilot test of a wide range of procedures for estimating design floods for ungaged catchments. The "index flood" method and the U.S. Geological Survey's regression estimators were the most precise as well as being easy to apply. W. Thomas reported on the Water Resource Council's development of Bulletin 15, 17, 17a, and 17b; the uniform approach currently recommended is based on an evaluation of operational procedures available in 1974.

The use of regional information to improve flood estimates at ungaged sites was addressed. G. Martin discussed an empirical Bayesian methodology and Monte Carlo results documenting its potential advantages. D. Lettenmaier presented another study; while certain empirical Bayesian procedures sometimes did well, others often did poorly in some respects.

The afternoon session addressed the use of "physically" based procedures for estimating flood flow distributions. Many questioned what that term meant. V. Klemes indicated that such procedures employed models based on some reasonable theory relevant to the phenomena in question. R. Bras noted that when a theory is inadequate to predict the phenomena's behavior, one must fall back on calibration and parameter estimation procedures. In such cases, the supposedly physically based models primarily serve to define a parametric probability distribution whose parameters must be estimated from available flood data just as the parameters of normal, lognormal, and Pearson distributions are often estimated.

P. Todorovic advocated the use of partial duration series procedures. By using more information than just the largest peak observed each year, they could provide more accurate design flood estimates than annual flood series procedures. V. Gupta considered the characteristics of the arrival process of significant rainfall and flood events. Finally, R. Bras discussed his work with J. Valdes, M. Diaz, I. Rodriguez-Iturbe, and M. Gonzalez on instantaneous unit hydrograph procedures which provide an estimate of the distribution of major floods using solely observable parameters describing physical characteristics of a basin plus the mean rainfall intensity and mean duration of storms. Results were promising and show that the theory, in addition to its significant scientific value, may be nearly ready to aid in the determination of flood distributions at ungaged sites.

The meeting closed with a panel discussion which reflected upon the papers presented and future research needs and opportunities. The importance of scale to hydrologic problems was discussed. There seemed to be universal agreement that several lines of research were coming to fruition and promised both scientific advances and operational improvements; furthermore, the need to keep in mind these dual purposes for hydrologic research was emphasized. Some research is oriented more toward advancing science and some toward water management concerns. This dichotomy has led to confusion when research, whose aim is to contribute to one of these objectives, is unjustly faulted for failing to contribute to the other. Attempts are being made to make a written summary of the panel discussion available; these can be obtained by writing J. R. Stedinger.

This meeting report was contributed by Jerry R. Stedinger, U.S. Geological Survey, 110 National Center, Reston, VA 22092.

## Multivariate Modeling

The special session entitled Multivariate Modeling of Hydrologic and Other Geophysical Time Series was held during the AGU Fall Meeting in San Francisco on Thursday, December 8, 1983, and was sponsored by the Surface Runoff Committee of the Hydrology Section of AGU. The session brought together about 100 participants from different disciplines, including hydrologists, oceanographers, meteorologists, and statisticians, to discuss the state of the art and new developments of stochastic description and modeling of multiple time series of hydrologic and geophysical phenomena.

The papers and discussion generated during the session covered a wide variety of hydrologic variables such as streamflow, precipitation, specific conductance, groundwater and water use, meteorologic variables such as air temperature, wind and pressure, and oceanographic variables such as ocean temperature and velocity. Among the topics discussed were: modeling that is oriented to data generation of multivariate processes, basic data analysis and description of statistical characteristics in time and space; modeling specifically oriented to forecasting the processes involved; transfer of hydrologic and geophysical information; and detection of changes in hydrologic information.

Positions, questions, and comments made during the panel discussion, in addition to stirring the pot a little bit, served to put several issues in perspective. One issue addressed was model complexity. One of the panelists, who may be the grandfather or perhaps the Godfather of synthetic hydrology, and who, having been present at the creation of some of the concepts about which much was heard and discussed in this special session, questioned whether anything substantial has been done. Is it necessary to have models with so many parameters? Is the information contained in any model or meta-model redundant or useful? Perhaps models, in their own metabolism have replaced processes, and we may be modeling models instead of real physical processes. In addition, the ease of computation may have led us to worry too much about micro-procedures. This may be regrettable, and a need for philosophy and new language may be in order. Some other panelists appeared to agree with the foregoing points, although more cautiously.

It has been about 20 years since the univariate AR(1) model was first suggested for modeling hydrologic processes; it has been about 15 years since the multivariate AR(1) model was suggested for modeling multisite processes; it has also been about 15 years since the ARMA models have become popular for modeling series of natural phenomena; and it has been about 10 years since the disaggregation model was first introduced in hydrology. Hence, it is not too surprising that the majority of the papers presented in the session reflected the experience gained during the last 10 years and the efforts to overcome some of the shortcomings inherent in some of the "traditional" models and approaches. For instance, there were lengthy discussions on the subject of models with parsimony in the number of parameters, both for the direct multivariate models, but for the disaggregation models. It is now clear that simple multivariate models retain the necessary flexibility of reproducing the basic properties shown by most annual time series of geophysical phenomena. Likewise, it is now clear that the major shortcoming of disaggregation models (i.e., the large number of parameters) may be overcome by step disaggregation, a scheme with a minimum number of parameters that preserves the needed cross-variances and additional property. These questions certainly have addressed the question of model complexity, redundancy, and parsimony which was put forward during the panel discussion.

Other points raised during the panel discussion include the following questions: Does anyone care about modeling and generation anyway? Is it really better to use synthetic samples than to use historical records alone? How would designers react to designs made from synthetic hydrology if these designs deviate significantly from those derived by conventional activities or those derived by simply looking at history? Could one not select a model which supported one's prior inclination? Has synthetic hydrology produced design suggestions well outside the limits proposed by historical records and conventional techniques? If so, have they been "explained away" or simply ignored as being mere artifacts of the random number generator?

Certainly we wish we could have answers to the foregoing questions, but any one answer will not please everyone concerned and will be controversial. Synthetic hydrology has been useful for considering various long-term flows. Documented studies have been made on the subject not only in the United States and Canada but in other countries as well. However, these issues, although quite important, were not discussed in the special session. The main purpose of the session was to discuss the state of the art and new developments in modeling multiple time series of hydrologic and other geophysical phenomena.

Perhaps it is now time to think and plan another meeting in the future to discuss more specifically the foregoing questions.

In summary, the special session served to identify some of the shortcomings of the traditional modeling techniques and the ways to circumvent them. It served to indicate how multivariate modeling of certain types of hydrologic processes such as annual streamflow may be effectively done with models that are simple, while modeling of periodic processes such as short-term precipitation as well as short-term meteorological and oceanographic events are more complex due to the extreme variability they often exhibit and due to the inherent irregular and gap-prone data bases which are available. The session also served to put some other relevant issues under perspective, such as those related to measuring the benefits of forecasts and evaluating and documenting the real usefulness of multivariate modeling techniques in the realm of practical decision making.

The exact titles and the abstracts of the papers may be found in *Eos*, Nov. 8, 1983. Interested readers should write to the authors for copies of the papers. On behalf of the Surface Runoff Committee of the Hydrology Section of AGU, the session organizers want to express his deep appreciation to all session participants for making this, along with the flood sessions, one of the best stochastic hydrology meetings in a number of years.

This meeting report was written by Jose D. Salas, Associate Professor of Civil Engineering, Colorado State University, Fort Collins, CO 80523.

### Article (cont. from p. 321)

#### Geochemical Reservoirs

On the basis of samples from many locations in the ocean, it is widely (but by no means universally) assumed that the oceanic lower crust resembles the base of subducted ophiolite sequences. For continental lower crust, however, we know only a few possible examples, represented by high grade granulite terrains and by xenoliths from volcanic pipes. Hence, the physical properties, compositional constraints, and scale of heterogeneity of the lower continental crust are poorly known.

Plate tectonics models suggest a long evolutionary history and probably great diversity. Do isotopic ages determined for the lower crust represent two ages of rock melts? Do ages match the oldest overlying upper crustal rocks, or have they been successively reset during additive processes from the upper mantle or from lateral subduction? The near mafic compositions of the deep crust postulated from seismic velocity data are difficult to reconcile with the silicic-to-intermediate gneisses seen in possible exposures of deep crustal rocks.

Major questions related to the composition and evolution of the upper mantle can be approached through xenolith research, but, again, there are more questions than answers. Are geotherms, derived from the equilibrium assemblages of peridotites and eclogites, transient phenomena related to mantle diapirism and kimberlite growth? Are inclusions in geotherms real? Are they related to thermal boundary layers? Are kimberlites produced by diapirs? Why are other magmas not produced with them? What are the scales of lateral and vertical heterogeneities implied by the varied xenolith suites in single pipes or localized groups of pipes? What are the mechanisms and kinetics of the widespread metamorphism of the uppermost mantle that is evident in omphacite or vesicic xenoliths and is required by several models of basalt genesis? Are isotopic ages of xenoliths apparent or real? Is suboceanic mantle different in composition from subcontinental mantle? What is the Mohorovicic discontinuity?

Fluxes of materials through subduction zones are crucial to the evolution of the lithosphere-mantle system but are poorly understood. It is widely believed that subduction zones are the loci of generation of new continental crust, but every link relating subduction to the various xenolith suites is still seriously debated. Important uncertainties include the source of island arc magmas, the source of their trace elements, the nature and degree of reworking of mature island arcs, the average composition of continental crust, and the relationship of the latter to island arc composition. Isotopic studies now suggest that ancient recycled oceanic crust and lithosphere may play an essential role in the production of modern mid-ocean ridge basalt (MORB) as well as ocean island basalts. The possibility that modern basalts are windows to ancient recycled crusts bears upon numerous aspects of mantle reservoirs and evolution and the kinematics of the subduction process itself. Furthermore, the synchronous appearance of volcanic activity over wide areas, both intraplate and at margins, suggests magmatic processes that may involve only an indirect relation to the movement of plates.

The number, size, and spatial arrangements of major geochemical reservoirs capable of yielding distinctively different signatures of being primordial ( $^{87}\text{Sr}/^{86}\text{Sr}$ ,  $^{143}\text{Nd}/^{142}\text{Nd}$ ). Components such as  $\text{H}_2\text{O}$  and  $\text{CO}_2$  may be recycled from crustal materials. Once introduced

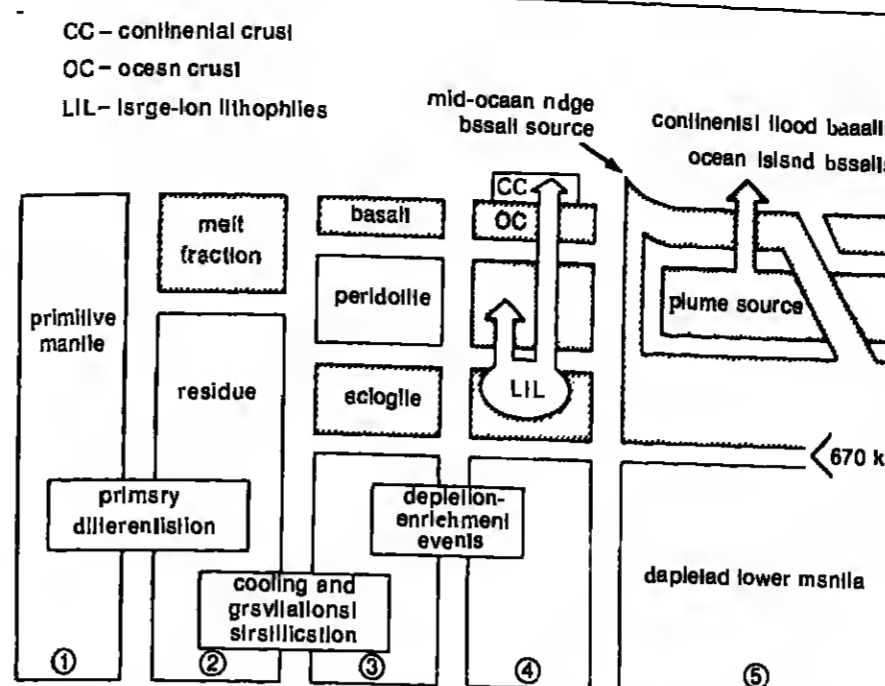


Fig. 4. A model for the evolution of the mantle. Primitive mantle (1) is partially molten either during accretion or by subsequent whole mantle convection, which brings the entire mantle across the solidus at shallow depths. LIL elements are concentrated in the melt. The deep magma ocean (2) fractionates into a thin, plagioclase-rich surface layer and deeper, olivine-rich and garnet-rich cumulate layers; (3) late-stage melts in the eclogite cumulate are removed (4) to form the continental crust (i.e.), enrich the peridotite layer, and deplete MORB's, the source region of oceanic crust (i.e.), and the lower oceanic lithosphere. Partial melting of the plume source (5) generates continental flood basalts (CFB), ocean island basalts (OIB) and other enriched magmas, leaving a light, depleted residue. (Source: Reprinted from D. L. Anderson, *Science*, 213, 82-89, 1981 with permission.)

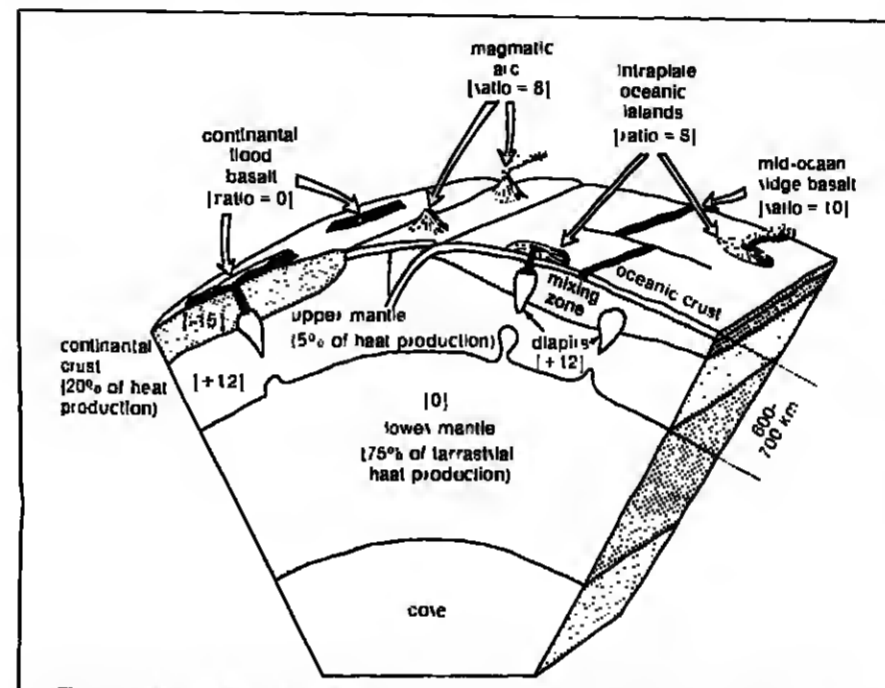


Fig. 5. Contrasting hypotheses for evolution of the earth's crust and mantle and for location of geochemical reservoirs. Figure 4 suggests a complex history of early earth differentiation leading to a depleted, inner lower mantle and a geochemically active upper mantle. A different model, from DePaolo, also emphasizes an active upper mantle, but shows plumes originating as diapirs from the lower mantle. (Source: Reprinted from D. J. DePaolo, *Eos Trans. AGU*, 162, 137-140, 1981.)

type postulates a primitive lower mantle, an enriched layer (at the top or the bottom of the mantle), and various enriched or depleted heterogeneities scattered through the mantle. Another requires continuing chemical exchange between the mantle and core and between the upper and lower mantles. In still other models the main magma reservoirs are in the upper mantle; the lower mantle is the depleted crystalline residue from early earth differentiation (Figures 4 and 5).

Information on the nature and magnitude of fluxes between reservoirs is essential to an understanding of the chemical and differentiation history of the earth. The nature, thickness, and origin of subcontinental lithosphere and its relationship to the overlying crust are subjects of widely divergent hypotheses, ranging from the view that its base is a thermal boundary layer directly analogous to oceanic lithosphere to the view that it is chemically distinct, thick, and a major reservoir of incompatible trace elements.

Oceanic island and ocean ridge basalts have recently been interpreted as having geochemical signatures of recycled ancient oceanic crust, raising anew the question of whether the differentiation of the mantle has proceeded irreversibly or is approaching a steady state with recycling. Oceanic island volcanic rocks are distinctly more enriched in incompatible trace elements than are mid-ocean ridge basalts. A globally accepted model assumes that the global extent of these latter

into the mantle, these volatiles will play a profound role in mantle magmatism, as shown by experiments with systems containing variable  $\text{CO}_2/\text{H}_2\text{O}$  ratios. Volatile transport in the mantle has been invoked as a mechanism to produce mantle metasomatism as a precursor to the production of basaltic liquids.

It appears unlikely that the current tectonic regime could have come into being on a totally pristine, undifferentiated earth. The formation of the earth by accretion was clearly a violent process, which probably involved extensive melting and stirring related to core separation, thermal convection, and convection driven by chemical buoyancy differences. The end product could have been a layered or inhomogeneous mantle, and any early formed crust may have been either thick or thin, buoyant or gravitationally unstable, and with very low or moderate abundances of the incompatible elements. However, an initially thick buoyant crust of basalt would have transformed into dense eclogite at its base as the mantle cooled. Thus, an initially buoyant crust could have converted to a dense, unstable crust with time. Such a process could destroy the early geological record.

Even if a form of plate tectonics began very early in earth history, other tectonic processes are likely to have been important. A magma ocean may have formed, as suggested by analogy with lunar history, or indeed the moon itself may have formed from the earth. The earth's geochemical inventory, the widespread current magmatism, combined with evidence that the earth has been cooling, also suggests that an extensive molten upper mantle existed in early earth history. Could such an upper mantle cool without forming cumulate layers and hence, chemical stratification?

Controversy exists as to whether the two largest discrete reservoirs, the core and the mantle, were ever in equilibrium with each other. The state of oxidation of the mantle, as currently postulated, is incompatible with equilibrium. The upper parts, and possibly

the entire mantle, may be contaminated by subducted and recycled crustal materials, particularly water. Thus, the presumed high oxidation state of the upper parts of the mantle may be an artifact of the subduction process. In any case, the high nickel content of the upper mantle seems to preclude equilibration with the core.

### Plate Tectonics Through Time

Identification of plate tectonic processes in the past depends on the assumption that we can read from the geological record the evidence that has been produced by these processes. The current assumption that continental crust cannot be subducted is yielding to contrary geological and geophysical evidence indicating a doubling of continental crust by underthrusting beneath some mountain systems. The possibility remains, however, that observed crustal thickening is the result of squeezing of two continental masses together, with minimal underthrusting. It will be possible to distinguish between these two types of collisions in deeply eroded ancient continental crust? Recent observations from deep seismic and electrical soundings suggest that this may indeed be possible.

In a presently active collision zone, such as that represented by the Alpine system and the Himalayas, opportunities exist for examining young and continuing orogenic phenomena. In addition to geological mapping and seismic and electrical methods of deep exploration, heat flow studies, and applications of modern space geodetic equipment to observations of ongoing deformation should be highly productive. Modern collision areas may also yield clues to the nature of ancient continental terrains such as the Hercynian and Grenville, where plate tectonics has provided no convincing model for understanding vast terrains characterized by complex deformation, uniformly reset ages, and a very thick crust. The apparent fragmentation of eastern Asia under the impact of the advancing Indian subcontinent may also provide a model for the generation of crustal fragments such as those now being recognized as allochthonous terrains in many orogenic areas.

From the study of plate motion areas over several million years, we have learned much about the style of plate tectonics, have confirmed the usefulness of the hypothesis that plates behave rigidly on this time scale, and have formulated models to explain the cause of their motion. In the coming decade we should focus on the style of plate tectonics over time scales both much longer and much shorter than several million years. For time scales of 10-100 m.y., individual plates appear to have episodes of constant motion, separated by major changes in direction and velocity. Changes in direction of motion of plates with respect to hot spots appear to be consistent with simple models in which plates are pulled to their subducted slab boundaries and pushed by their spreading ridge boundaries. Velocity is greater for plates with a large fraction of their boundaries attached to down-going slabs. It is important to test critically whether these generalizations hold for all Cenozoic and Mesozoic plate motions and especially whether the change in plate boundaries causes a change in plate directions and velocities, or vice versa. Because present seafloor has been formed since the breakup of Pangea and because continental hot spot tracks are difficult to recognize, the primary source of information on pre-Jurassic plate motions will be paleomagnetic data combined with accurate age dating. We do not yet know whether plate tectonic regimes are episodic on time scales longer than 100 m.y. Among many other unanswered questions are these: Was the episode of plate motions and continental drift prior to the breakup of Pangea preceded by a long quasi-static interval of little or no continental drift on an earth with just one continent? Is the apparent polar wander of the major continents before the breakup of Pangea the result of plate motion or of true polar wander?

Almost nothing is known about episodicity of plate motion on a time scale of years or decades. A tectonic mechanism clearly operates to hold plates locally fixed by friction at active margins until the strength of crustal rocks is exceeded; the resulting rupture causes local movement and devastating earthquakes. Occasional displacement inputs are large (tens of meters and greater), and plate movements are small (a few centimeters per year). Thus, the superposition of strain events may contribute significantly to plate movements. Near active margins, crustal movements are highly inhomogeneous in space as well as time. Creep rates determined across various parts of the boundaries are both smaller and larger than those predicted by existing plate models. New geodetic techniques are able to monitor plate movement and deformation over baselines hundreds or thousands of kilometers in length and are now being used for essentially continuous measurement of the relative and absolute motion of the Pacific, Nazca, North American, South American, Australian, and Eurasian plates. The accuracy of these measurements is a few

centimeters, so it will be on the order of a decade before meaningful velocities will be available.

Intriguing aspects of volcanism have been noted which seem to require major perturbations of the plate tectonic model. Evidence has been presented that volcanism is strongly episodic and that certain pulses have been synchronous over wide regions, including marginal orogenic belts, intraplate hot spots, and continental rifts. If true, the factors governing volcanism must be global and unrelated to local conditions such as rates of subduction or seafloor spreading. Of particular interest are the production rates of volcanism necessary to generate the elevated plateau regions of the Pacific and the extensive Cretaceous episode of volcanic activity thought to have occurred in the interior of the Caribbean and in the central and western Pacific Ocean.

Vertical tectonic movements, though less spectacular than horizontal motions, can be easily observed and are clearly episodic on various time scales. The gradual subsidence of passive continental margins through time can be modeled as a response to the loss of heat. But what about the interior regions of the continent? Episodic subsidence of basins and elevation of domes within continents are well known, whereas other cratonic areas appear to have been extremely stable. Are there processes occurring at the crust-mantle boundary, causing continental thinning or thickening which would, in turn, produce elevation changes at the surface of the continents?

It appears that all plates, spreading ridges, and trenches are in relative motion. Therefore, none of these features can serve as a fixed reference frame. The spin axis provides the only widely accepted "absolute" reference frame. Assumptions of past positions of the spin axis come largely from magnetic data and from determinations of the positions of ancient equators by geological analysis of deep-sea drilling cores and by analyses of paleomagnetic indicators. The apparent polar wander paths of major continents have been determined for substantial portions of the Phanerozoic. With this information it has been possible to test independently the accuracy of seafloor spreading reconstructions and to estimate the rates of continental drift with respect to the spin axis.

However, the assumption that plate motion with respect to the spin axis is identical to plate motion with respect to the mantle can be challenged if true polar wander has occurred. If true polar wander is to be established, absolute reference frames other than the spin axis must be defined. Proposed reference frames include hot spots based on the assumption that hot spots originate in the lower mantle) and mathematical reference frames that minimize the motion of the lithosphere or minimize the motion of ridges and trenches. For shorter periods (years and decades) the inertial reference frame and a fixed star reference frame can be defined from satellite and astronomical data. When applied to plate motions over the last few million years, all of these reference frames have been found to be similar, the differences being on the order of one tenth of a degree per m.y. An important emerging problem is to determine whether the small differences between reference frames are significant.

### Ninety Years of Progress

Charles L. Drake puts in perspective the problems with which we are struggling today. His essay highlights the 1892 Presidential address by Grove Karl Gilbert to the Geological Society of America as a reference point to important geological problems of 90 years ago. It is a bit disarming to note that many of those same problems are still with us. His closing remark "... if we are optimists, we may be comforted by the reflection that geologists of this generation, at least, will have no occasion, like Alexander, to lament a dearth of worlds to conquer," is equally appropriate today.

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## News

## Eagleson Voted President-Elect



Peter S. Eagleson

Peter S. Eagleson, professor of civil engineering at the Massachusetts Institute of Technology, was chosen AGU President-Elect, according to a report from the AGU Tellers Committee on the recent elections. The Tellers report will be formally presented to the AGU Council at the Spring Meeting in Cincinnati on May 13.

Peter M. Bell, of the Geophysical Laboratory of the Carnegie Institution of Washington, has been elected AGU General Secretary. He succeeds Leslie H. Merriam, Jr., of the Geophysical Institute of the

University of Alaska, Fairbanks, will succeed Carl Kinsinger as Foreign Secretary. The 4-year terms for the general secretary and foreign secretary end June 30, 1988.

The Tellers Committee reports that 3,964 valid ballots—24% of the 16,496 ballots mailed—were received by the March 30 voting deadline. A list of the "write-in" votes will be given to the next nominating committee.

The results of the section elections are listed in Table 1. The new section officers will serve AGU from July 1, 1984, through June 30, 1986. Each section president-elect will serve 2 years in that capacity and then serve 2 years as section president. They will be voting members of the AGU Council for all 4 years.

On July 1, the following section presidents-elect will assume 2-year terms as section presidents:

Atmospheric Sciences, Fred D. White; Geodesy, Byron D. Tapley; Geomagnetism and Palaeomagnetism, Neil O. Podyke; Hydrology, R. Allan Freeze; Ocean Sciences, Joseph L. Reid; Planetary, Laurence A. Soderblom; Seismology, Lynn R. Sykes; Solar-Planetary Relationships, George G. Reid; Tectonophysics, Thomas J. Ahrens; Volcanology, Geochemistry, and Petrology, G. Brent Dalrymple.—BTR

TABLE 1. AGU Section Election Results

Section	President-Elect	Secretary
Atmospheric Sciences	Ralph J. Gierone	Rex J. Fleming
Geodesy	John D. Bosler	James J. Marsh
Geomagnetism and Palaeomagnetism	John K. Hameed	John W. Hillhouse
Hydrology	Marshall E. Moss	Thomas Maddock III
Ocean Sciences	Arnold L. Gordon	Barbara M. Hickey
Planetary	Seatt C. Solomon	Raymond E. Arvidson
Seismology	Steven W. Smith	William L. Ellsworth
Solar-Planetary Relationships	R. A. Helliwell	G. G. Skjerve (Astronomy); Leonard F. Burlaga (Cosmic Rays); George K. Parks (Magnetospheric Physics); Bruce T. Tsunemi (Solar and Interplanetary Physics)
Tectonophysics, Volcanology, Geochemistry, and Petrology	Richard P. Von Herzen	Barry Parsons
	P. Rubin Bretz	Bruce D. Marsh

## New Climate Delivery System Developed

The Illinois Climate Center can now provide information through the Climate Assistance Service (CLASS) about the current status of many weather parameters, such as accumulated degree days, differences between seasonal rainfall and normal, and long-range future climate predictions. Illinois is the first state to start such a near real-time climate information system where the observations are gathered from National Weather Service cooperative observers.

The concept of CLASS was envisioned and designed by Stanley Chappin, chief of the Illinois State Water Survey; Wayne Wendland, head of the Climatology and Meteorology Section; and John Vogel, head of the survey's Climate Information Unit. Grants from the Illinois Department of Energy and Natural Resources and from the National Oceanic and Atmospheric Administration (Climate Analysis Center and National Climate Program Office) were compiled with existing Survey funds and information products of the Illinois State National History Survey to develop this system.

The Illinois Water Survey developed a plan for a Climate Information Center for Illinois 5 years ago. This center now gathers most of the state's natural resource data on weather and climate into its computers. By late 1981, anyone in Illinois will be able to obtain data and information quickly that before were difficult to obtain sooner than 1 or 2 months after the fact. Complex information about the state's past atmospheric resources will be generated. Currently, only state agencies are accessing the data and information in a fast test.

CLASS will be usable by a variety of interests, which follow: (1) Agricultural interests can access growing degree day information for major crops, information on insect pest outbreaks, and soil moisture measurements for planting and irrigation decisions. (2) Energy interests can plan and monitor coal gas

and oil supplies by accessing information on heating degree days in winter and cooling degree days in summer. (3) Transportation concerns can monitor extremes of temperature, precipitation, ground frost, and snowfall to plan for repairing roads and highways. (4) Water resources managers can monitor precipitation accumulations and predictions to manage water systems better. (5) Air and water quality regulators can monitor the evolving conditions that affect water quality such as prolonged deficiencies of rainfall or air stagnation. (6) Those concerned with natural resources including conservation can monitor the general status of basic atmospheric conditions, including extremes of temperature, moisture, or drought events which have detrimental effects on the flora or fauna of the state.

This new item was submitted by Stanley A. Chappin, John L. Vogel, and Wayne M. Wendland from the Illinois State Water Survey, Champaign, Ill.

## World's Carbon Budget: Sinks and Sources

Interest in natural and man-made carbon dioxide production is shared because it resides after formation in critical atmospheric zones. To determine the outgoing "greenhouse" effect, indeed to determine whether there will be a greenhouse effect, investigators have tried to sum up the global carbon cycle. In accounting for the sinks and sources of carbon dioxide produced at the earth's surface, it has been justified that most of the unlabeled sources can be identified with the earth's biomass and not so much with man's combustion of fossil fuels (*Eos*, March 33, 1983). New figures on the calculated values of tropical forests suggest otherwise.

S. Brown of the University of Illinois Department of Forestry and A.E. Lugo of the Institute of Tropical Forestry, Rio Piedras, Puerto Rico, calculated values for the total biomass as 215 x 10<sup>12</sup> tons. They determined weighted biomass densities for undisturbed closed and open broad leaf forests as 176 and 61 tons per hectare. To quote their recent report: "These values are considerably lower than those previously reported and raise questions about the role of the terrestrial biota in the global carbon budget" (*Science*, 223, 1290, 1984).

The question is an important one. If the release of carbon dioxide to the atmosphere can be assessed correctly, it may be possible to reduce the total amount. Conceivably, a reduction may not delay the consequences of a

global mean temperature rise, but there are many unknowns in determining the proportions. A critical factor may be assessment of the contribution to global carbon dioxide from the biota. It is believed that recent imbalances in the carbon budget have resulted from changes in tropical forest regions.

Deforestation along the equatorial belt results in burning or produces large volumes of decaying biomass, both of which yield carbon dioxide in the form of greenhouse gases, as well as the amount of deforestation. There are many factors, such as wood density and forest expansion and productivity, that are difficult to estimate.

Brown and Lugo noted that the data base available for making estimates of the biomass is limited. Instead they calculated the carbon pool in tropical forests from data on the volume of standing timber extending over a large area, which included 97% of the tropical belt area. The result is that the global carbon budget could be balanced after all.—PMB



## Year of the Ocean

A national celebration of the oceans and their products will begin July 1 when the "Year of the Ocean" officially opens. A preliminary kickoff reception was held in March. The goal of the celebration is to increase awareness of the importance of the oceans. "It is vital that we now look toward finding workable solutions to the vast and varied issues surrounding the wise use and management of our seas," said John V. Byrne, administrator of the National Oceanic and Atmospheric Administration (NOAA) and chairman of the board of the Year of the Ocean Foundation. The foundation includes public and private organizations.

"The time is right to initiate new activities and reawaken Americans to the tremendous potential of this great resource," he added. "The Year of the Ocean will act as a springboard to increase awareness and understanding of our treasured oceans and act as a national forum for shared goals and objectives among ocean users."

To help meet these objectives, nearly one dozen roundtable discussions will be held among those working on the ocean in academia, industry, and policy making, according to Diane C. Boratyn, national coordinator for the celebration. The roundtables will be designed to facilitate collaboration among leaders in ocean users and policy and decision makers to raise, examine, and recommend resolutions on topical ocean issues.

Ocean Day, slated for July 1, will open the celebration, which will continue for 1 year with activities sponsored by the federal government, industry, state and local governments, academia, and ocean organizations. A five-part television special series also is being planned.

For additional information, contact Ilana-tyng, Box 1100, 3421 M Street, N.W., Washington, DC 20007 (telephone: 202-333-1188).

CO<sub>2</sub> and Sea Level

There is considerable discussion currently about the potential effects of vast carbon build-up in the atmosphere over the next several decades. The sources of information are several Governmental reports, one by the National Research Council (NRC), the other by the Environmental Protection Agency (EPA). Both were released within the last few months. The reports were described recently as being conservative, although the consequences of the resulting greenhouse effects are deemed inevitable. Atmospheric warming on a global scale of as much as 3°C cannot be avoided, only perhaps delayed by a few years at best (Korhonen, *Sci. Technol.*, 18, 15A-16A, 1984).

The cause is the burning of fossil fuels. Oil will not be too important because its supplies are predictably exhausted on the time scale of 50-100 years. Coal burning is considered as the main source of carbon dioxide. Among the more spectacular results of a global temperature rise over the next 100 years is the expected rise in sea level of a minimum of 70 cm (Korhonen, *Winter*, 1983/84). If the West Antarctic Ice Sheet melts and the ice melts, the rise could be in the several meter range. Sea level rise only 15 cm in the past century.

An example of the sea level rise in Boston, MA, was given by T. C. Schelling of Harvard University (*Science*, 192, 12). If the sea level rises, Boston and Cambridge, Massachusetts would be essentially flooded. The answer in this instance would be the construction of dikes, much as been done for a long time in Holland. This, and other examples of sea level rise and warming effects, will be the focus of not being too serious if you can adjust and adapt.

The EPA study is pessimistic about changing the inevitable trend. The NRC study sees no cause for sudden alarm, but recommends detailed studies. One of the so far unresolved factors is the contribution from gases other than carbon dioxide. Other "greenhouse gases" include nitrous oxide, methane, and chloro- and fluorocarbons.—PMB

## Geophysicists

Roger R. Revelle, an oceanographer, paleontologist, scientist, and professor of science and public policy at the University of California at San Diego, will be presented with the fifth Vannoy Award by the National Science Foundation (NSF), the 25-member policy-making body of the National Science Foundation, at the board's annual dinner on May 9.

The award is presented from time to time to acknowledge outstanding contributions in science and technology that are particularly significant to the national welfare. In announcing the award, NSF Chairman Lewis M. Branscomb said, "Professor Revelle's career has long been devoted to the conviction that science can make a great contribution to the welfare of people everywhere—especially the poorest people. His work is known and admired by people all over the world, and his living demonstration that science and humanism can be natural companions." Revelle, an AGU Fellow, was director of the Scripps Institution of Oceanography from 1950 to 1984, and was one of the founders of both the International Geophysical Commission and the Scientific Committee on Ocean Research of the International Council of Scientific Unions.

## Chapman Conference on the Magnetospheric Polar Cap

A Chapman Conference on the Magnetospheric Polar Cap will be held August 6-9, 1984 at the University of Alaska, Fairbanks Campus. Conference co-convenors are S.-I. Akasofu and J. R. Kan.

This conference will provide a unique opportunity for researchers to discuss various aspects of polar cap phenomena, the magnetospheric and the effects of the interplanetary magnetic field. The magnetospheric polar cap is the largest feature in the upper atmosphere bounded by the auroral oval. It has attracted much attention during the last several years. Discussions will emphasize an examination of how polar cap phenomena are controlled by solar wind and the interplanetary magnetic field.

There will be invited review and invited contributed presentations. The Call for Papers was published in the January 24, 1984 issue of *Eos*. Abstract Deadline is May 1, 1984.

Limited funding is available to support student travel. The deadline date for student travel applications is May 1, 1984. Call AGU to request a travel grant application.

For information on the required abstract format or further meeting logistics, contact:

AGU Meeting Department:  
2000 Florida Avenue, N.W.  
Washington, DC 20009  
(202) 462-6903.

For program information, contact:  
S.-I. Akasofu or J. R. Kan  
University of Alaska  
C. T. Elvey Building  
Fairbanks, AK 99701  
(907) 474-7282

## Classified

## RATES PER LINE

Positions Available, Services, Supplies, Courses, and Announcements: first insertion \$5.00, additional insertions \$4.25.  
Positions Available: first insertion \$2.00, additional insertions \$1.50.  
Student Opportunities: first insertion free, additional insertions \$2.00.

There are no discounts or commissions on classified ads. Any type style that is not published is charged a general advertising rate. *Eos* is published weekly on Tuesday. Ads must be received in writing by Monday, 1 week prior to the date of publication.

Replies to ads with box numbers should be addressed to Box — American Geophysical Union, 2000 Florida Avenue, N.W., Washington, DC 20009.

For more information, call 802-462-8803 or toll-free 800-424-2488.

## POSITIONS AVAILABLE

Eastern Illinois University/Department of Geography and Geology: Teaching Position in Geology.

The Department of Geography and Geology at Eastern Illinois University is accepting applications for a temporary one year position in geology starting August 25, 1984. Candidates are very good that this position will become full-time tenure track. A Ph.D. is required. Rank will be at the assistant professor level. The candidate will be expected to teach physical and historical geology. The candidate will be given a teaching assignment that will be given to the following: an introductory course in geology, economic minerals, geology, hydrology, and field geology. Other specialties will definitely be considered. If the position becomes permanent, teaching at summer field camp and the pursuit of research will be expected.

The Department has 45 full-time geologists and approximately 120 undergraduate geology majors.

APPLICATION PROCEDURE:

(1) Application deadline is May 31, 1984. Each completion of application is encouraged.

(2) Individuals wishing to apply should immediately make their interest known to:

Dr. Gary Wallace, chairman  
Department of Geography and Geology  
Eastern Illinois University  
Charleston, Illinois 61820

Telephone office: (317) 381-2028; home: (317) 381-3772.

(3) Candidates should attach the following materials to the above address as soon as possible:

a) Letter of application

b) A current vita

c) Transcripts from all institutions from where college credits have been earned

d) Arrange for three letters of recommendation to be sent. Send names, addresses, and telephone numbers of referees with letter of application.

Eastern Illinois University is an equal opportunity employer.

Software Systems Engineer. Candidate will be responsible for the continuing development, maintenance and improvement of software systems which form a part of the real-time control, data processing and data recording portions of a state-of-the-art high resolution, high resolution radar system used for imaging near earth and deep space targets. The system involves three general purpose computers (Mortump, Cray, and two special purpose array processors). The complexity of the system presents a considerable challenge. The person selected should be prepared to accept a strong personal responsibility for the continued improvement and operational reliability of the software system, and should be prepared to work unusual hours on occasion.

Strong mathematical and engineering or physics background is required as well as a good knowledge of both assembly and FORTRAN computer languages. An appropriate bachelor's degree and at least two years of applicable experience are required. Must be capable of working with limited supervision.

Please write, enclosing resume to:

L. T. Katalin

Assistant to the Director

Hawstack Observatory

Westford, MA 01886

MIT is an equal opportunity/affirmative action employer.

Cooperative Institute for Climate Studies/Postdoctoral Fellowship. The Department of Meteorology at the University of Maryland, College Park has established the Cooperative Institute for Climate Studies (CICS) with NOAA to engage in collaborative research. The Institute is involved in a variety of studies oriented toward a better understanding of climate and currently has openings for three postdoctoral fellows to join with the current Institute staff. Details of the areas of study are as follows:

A. Shortwave Radiation Modeling: This position will involve research toward the development of a detailed climate model that includes the application of radiative transfer models in the interpretation of radiation measurements. Additional research may include radiation models for the interpretation of satellite data and the development of Earth Radiation Budget Experiment (ERBE).

B. Earth Radiation Budget Analysis: This research program involves analysis of the relationship between general circulation and the atmospheric energy budget to the net radiational forcing utilizing data from numerical analysis-forecast models, general circulation models and satellite observations of the planetary radiation budget. Both theoretical and observational aspects of this important problem will be considered.

C. Study-State Climate Modeling: This position calls for a meteorologist with experience in climate model experiments with steady state climate models. Primary activities will involve running experiments with current models, deriving careful verification procedures, handling extensive observational data, making modifications in model computational schemes for running the models.

Letters of application should be sent to:

E. R. Riser, Director CICS

Department of Meteorology

University of Maryland

College Park, MD 20742

Applications should include a curriculum vitae and names of three referees. Applications received before May 15, 1984 will receive full consideration.

The University of Maryland subscribes to a policy of equal educational and employment opportunity. The University of Maryland, under Title IX of the Education Amendment of 1972, does not discriminate on the basis of sex in admission, treatment of students or employment.

Air Force Geophysics Laboratory Geophysics Scholar Program (1984-1985). The Air Force Geophysics Laboratory (AFGL) and the Southwest Center for Technical Engineering Education (SWCTEE) announce that applications are invited for 10 full-time appointments during the 1984-1985 academic year in the Geophysics Scholar Program. This program provides research opportunities of 10 to 12 months to students in geophysics and sciences to do research in the field of geophysics. The program is open to students in the U.S. and Canada. Students will be selected from among students who are currently in the Applied Science, Mathematics, or Engineering fields. To be eligible, candidates must have a Ph.D. or equivalent experience in an appropriate field of study. Some appointments may be continued from August 1985 to early applications are encouraged. All qualified applicants will receive consideration without regard to race, color, religion, sex, or national origin. Application deadline for consideration is August 1, 1984. For further information and application forms contact: SCHEP, 1101 Massachusetts Avenue, St. Louis, MO 63101. Telephone: (314) 392-6101.

SCHEP supports Equal Opportunity/Affirmative Action.

Scientist/Engineer. The Harvard Observatory is seeking a Scientist/Engineer to work in the field of Very Long Baseline Interferometry (VLBI). The Scientist/Engineer would assist in the development of VLBI data processing electronics as well as in the design and construction of the VLBI system for the NASA/CNRS Dynamics Project. The applicant should have a Ph.D. or its equivalent in radio astronomy or a related field. Some engineering knowledge and experience with electronics is needed and a knowledge of computer and microprocessor programming would be an asset.

Please write, enclosing resume, to:

Assistant to the Director

Hawstack Observatory

Westford, MA 01886

MIT is an equal opportunity/affirmative action employer.

Electronic Engineer. The MIT Haystack Observatory has an opening for an Electronic Engineer to design and develop electronic equipment for Radio Interferometry and Very Long Baseline Interferometry (VLBI) measurements for radio astronomy and geodetic applications. Duties include design and construction of RF systems using mixers, amplifiers, and other electronic components. A Ph.D. or its equivalent in electrical engineering or a related field is required. Some experience with computer programming and digital logic is preferred. The position is full-time and requires relocation to Westford, MA. Please write, enclosing resume, to:

L. T. Katalin

Assistant to the Director

Hawstack Observatory

Westford, MA 01886

MIT is an equal opportunity/affirmative action employer.

University of East Anglia/Lectureship in Geophysical Fluid Dynamics. Applications are invited for a "New Blood" Lectureship in the School of Mathematics and Physics. The candidate will be responsible for research in the field of geophysical fluid dynamics and for teaching in the field. The position is full-time and requires relocation to Norwich, Norfolk. Please write, enclosing resume, to:

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L. T. Katalin

Assistant to the Director

Hawstack Observatory



## University, Dallas, TX 75275; tel.: 214-

50-1 [Jan. 17, 1984].

50-29 Geothermal Resources Council  
Annual Meeting, Reno, Nev. (Geothermal Resources Council, 1980, Davis  
617; tel.: 916-758-2560.) [Feb. 7, 1984.]

50-31 Sereñiti Australian Sponsor, Geo-  
society of Australia. (Secretary 7 AGC,  
Box 383, North Ryde, NSW, Australia  
[Nov. 21, 1983].)

50-31 Sereñiti IAHR Symposium,  
Garmisch-Partenkirchen, Germany, see En-  
ding D. (Lamberg-Lehrstuhl für Schiffbau, Ver-  
fahrenstechnik, P.O. Box 600 929, 2000  
Hamburg, FRG.) [Nov. 22, 1983.]

50-31 Sept. 6 (General Assembly of URSI,  
c/o Italy, (Vito Cappellini, IROE, Via  
della 61, 50122 Firenze, Italy.) [Dec. 27,

7. Quadecennial Ozone Symposium, Thessaloniki, Greece. Sponsors, IAMAP International Ozone Commission (IOC), Commission European Communites, the Academy

ans, and WLO. (Christos S. Zerolios,   
man, Local Organizing Committee,   
Dept., Campus Box 148, Univ. of   
Michigan, Thessaloniki, Greece. Send copy   
requesting request to: Dr. V. Vlahos, Sec-   
IO, Clarendon Laboratory, Oxford,   
Parks Road, Oxford, OX1 3PU, UK.)   
-12 Oceano 84 Conference and Exhibi-   
Washington, D.C. Sponsors: Marine   
ology Society, AGU, AGU Institute,   
and Electronics Engineers/Oceanic   
Engineering Society. (Oceans 84 Technical   
Committee, 1730 M St., N.W., Suite   
Washington, DC 20036. Tel: 202/462-8883.)   
-13 International Symposium on Geo-   
chemical Balances of Fresh Water Sys-   
Stockholm/Uppsala, Sweden. Sponsors:   
National Science Research Council,   
IAHR, IAGLR, IAGLR, IAGLR, IAGLR,   
FRS, Comp. Int. Hydrology, Box 6711,   
35 Stockholm, Sweden.)   
-14 Seminar on Degradation, Recomi-   
Dispersion of Pollutants in a Ground-   
water Aquifer, Copenhagen, Denmark.   
International Association on Water Pollution Re-

-21 International Symposium on Environmental Pollution, Site To Be Announced. (Erik Arvin, Dept. of Industrial Engineering, Building 115C, Technical Univ. of Denmark, DK-2800 Lyngby, Denmark.) (Dec. 13, 1983.)

ed. V. M. Blinnager, Box 1779, Corn-  
wallar Kijl 3V7, Canada.)  
-25 Seminar: Enhanced Biological  
vol of Phosphorus From Wastewater.

France. Sponsor, International Association Water Pollution Research and Control-Michel Floerz, Phosphorus Seminar, 10-12, 13-14, 15-16, 17-18, 19-20, 21-22, 23-24, 25-26, 27-28, 29-30, 31-32, 33-34, 35-36, 37-38, 39-40, 41-42, 43-44, 45-46, 47-48, 49-50, 51-52, 53-54, 55-56, 57-58, 59-60, 61-62, 63-64, 65-66, 67-68, 69-70, 71-72, 73-74, 75-76, 77-78, 79-80, 81-82, 83-84, 85-86, 87-88, 89-90, 91-92, 93-94, 95-96, 97-98, 99-100, 101-102, 103-104, 105-106, 107-108, 109-110, 111-112, 113-114, 115-116, 117-118, 119-120, 121-122, 123-124, 125-126, 127-128, 129-130, 131-132, 133-134, 135-136, 137-138, 139-140, 141-142, 143-144, 145-146, 147-148, 149-150, 151-152, 153-154, 155-156, 157-158, 159-160, 161-162, 163-164, 165-166, 167-168, 169-170, 171-172, 173-174, 175-176, 177-178, 179-180, 181-182, 183-184, 185-186, 187-188, 189-190, 191-192, 193-194, 195-196, 197-198, 199-200, 201-202, 203-204, 205-206, 207-208, 209-210, 211-212, 213-214, 215-216, 217-218, 219-220, 221-222, 223-224, 225-226, 227-228, 229-230, 231-232, 233-234, 235-236, 237-238, 239-240, 241-242, 243-244, 245-246, 247-248, 249-250, 251-252, 253-254, 255-256, 257-258, 259-260, 261-262, 263-264, 265-266, 267-268, 269-270, 271-272, 273-274, 275-276, 277-278, 279-280, 281-282, 283-284, 285-286, 287-288, 289-290, 291-292, 293-294, 295-296, 297-298, 299-300, 301-302, 303-304, 305-306, 307-308, 309-310, 311-312, 313-314, 315-316, 317-318, 319-320, 321-322, 323-324, 325-326, 327-328, 329-330, 331-332, 333-334, 335-336, 337-338, 339-340, 341-342, 343-344, 345-346, 347-348, 349-350, 351-352, 353-354, 355-356, 357-358, 359-360, 361-362, 363-364, 365-366, 367-368, 369-370, 371-372, 373-374, 375-376, 377-378, 379-380, 381-382, 383-384, 385-386, 387-388, 389-390, 391-392, 393-394, 395-396, 397-398, 399-400, 401-402, 403-404, 405-406, 407-408, 409-410, 411-412, 413-414, 415-416, 417-418, 419-420, 421-422, 423-424, 425-426, 427-428, 429-430, 431-432, 433-434, 435-436, 437-438, 439-440, 441-442, 443-444, 445-446, 447-448, 449-450, 451-452, 453-454, 455-456, 457-458, 459-460, 461-462, 463-464, 465-466, 467-468, 469-470, 471-472, 473-474, 475-476, 477-478, 479-480, 481-482, 483-484, 485-486, 487-488, 489-490, 491-492, 493-494, 495-496, 497-498, 499-500, 501-502, 503-504, 505-506, 507-508, 509-510, 511-512, 513-514, 515-516, 517-518, 519-520, 521-522, 523-524, 525-526, 527-528, 529-530, 531-532, 533-534, 535-536, 537-538, 539-540, 541-542, 543-544, 545-546, 547-548, 549-550, 551-552, 553-554, 555-556, 557-558, 559-560, 561-562, 563-564, 565-566, 567-568, 569-570, 571-572, 573-574, 575-576, 577-578, 579-580, 581-582, 583-584, 585-586, 587-588, 589-590, 591-592, 593-594, 595-596, 597-598, 599-600, 601-602, 603-604, 605-606, 607-608, 609-610, 611-612, 613-614, 615-616, 617-618, 619-620, 621-622, 623-624, 625-626, 627-628, 629-630, 631-632, 633-634, 635-636, 637-638, 639-640, 641-642, 643-644, 645-646, 647-648, 649-650, 651-652, 653-654, 655-656, 657-658, 659-660, 661-662, 663-664, 665-666, 667-668, 669-670, 671-672, 673-674, 675-676, 677-678, 679-680, 681-682, 683-684, 685-686, 687-688, 689-690, 691-692, 693-694, 695-696, 697-698, 699-700, 701-702, 703-704, 705-706, 707-708, 709-710, 711-712, 713-714, 715-716, 717-718, 719-720, 721-722, 723-724, 725-726, 727-728, 729-730, 731-732, 733-734, 735-736, 737-738, 739-740, 741-742, 743-744, 745-746, 747-748, 749-750, 751-752, 753-754, 755-756, 757-758, 759-760, 761-762, 763-764, 765-766, 767-768, 769-770, 771-772, 773-774, 775-776, 777-778, 779-780, 781-782, 783-784, 785-786, 787-788, 789-790, 791-792, 793-794, 795-796, 797-798, 799-800, 801-802, 803-804, 805-806, 807-808, 809-810, 811-812, 813-814, 815-816, 817-818, 819-820, 821-822, 823-824, 825-826, 827-828, 829-830, 831-832, 833-834, 835-836, 837-838, 839-840, 841-842, 843-844, 845-846, 847-848, 849-850, 851-852, 853-854, 855-856, 857-858, 859-860, 861-862, 863-864, 865-866, 867-868, 869-870, 871-872, 873-874, 875-876, 877-878, 879-880, 881-882, 883-884, 885-886, 887-888, 889-890, 891-892, 893-894, 895-896, 897-898, 899-900, 901-902, 903-904, 905-906, 907-908, 909-910, 911-912, 913-914, 915-916, 917-918, 919-920, 921-922, 923-924, 925-926, 927-928, 929-930, 931-932, 933-934, 93

4-28 SLEAIS (Salt Lakes, Evaporites, and Saline Deposits) Working on Cenozoic Salt and Arid Zone Hydrology, Geochemistry, Geomorphology, and Paleo-environments, University of New South Wales, Australia. Spatially Australian National University, c/o M. J. M. (ed.), Dept. of Hydrographic and Oceanography, Research School of Pacific Studies, Australian National University, GPO Box 1, Canberra 2601, Australia. (March 27, 1984.)

City Symposium, Las Vegas, Nev. Sponsored by the National Water Well Association, 1000 W. Wilson Bridge Rd., Worthington, OH 43085; tel.: 614-846-9955.

5. International Symposium on Recent  
 Investigations in the Zone of Aeration, Mu-  
 FRG. Sponsor, Technical Univ. of Mu-  
 FRG. Ullrich, RIZA Symposium, Institut  
 Vasserchemie der TU München, Mu-  
 FRG. 17. D-8000 Munich 70, FRG.)  
 20, 1983.)

5 European Seismological Committee, Moscow. (Organizing Committee, ESC, 1 Geophysical Institute, Bolodetchnaya 7 296 Moscow, USSR.)

5 Symposium on Meteorology and Geography of Northern High Latitudes, Anchorage, Alaska. Sponsors, American Meteorological Society and AAAS. (Stuart Bigler, National Weather Service, 701 C St., P.O. Box 100, Anchorage, AK 99513.) (March 8, 1984.)

11 World Conference on Remote Sensing

—12 Sedimentological Society of America  
 9th Section 58th Annual Meeting, St.

Mo. (Robert B. Herrmann, Dept. of  
and Atmospheric Sciences, St. Louis  
P.O. Box 8099, St. Louis, MO 63136;  
14-658-5120.)

—19 International Symposium on Lake Watershed Management: Local Involvement, McAfee, N.J. Sponsor, North American Management Society. (Harry Gibbons,

Dept. of Civil and Environmental Engineering,  
Washington State Univ., Sloan Hall  
Pullman, WA 99164-2912.) (March 8,  
1991)

—19 AIPG Annual Meeting, Orlando,  
Bobby J. Timmons, General Chairman,  
Monks Associates, P.O. Box 50008, Jack-  
sonville, FL 32250; tel.: 904-246-4555.

—88 Chesapeake Conference on Wetland

Nov. 3 Symposium on Relationships  
between Climate of China and Global Clima-  
-te, Present, and Future, Peking, Chi-  
-na. Participants: Academia Sinica, International  
-Association of Meteorology and Atmospheric  
-Sciences (IAMAP), American Meteorological  
-Society, etc. (In-Press, China Institute of Atmo-

Nov. 7: Regional Assembly of IAGLR, Hyderabad, India. (Mohn L. Gupta, Organizing Committee, IASPEI Regional Assembly, National Geophysical Research Institute, Hyderabad 500 007, India; telex 155-155155.)

**Meetings (cont. on p. 332)**

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